

ANSWERS: Crystal ball: Bond Enthalpy calculations

1)

<p>bond breaking</p> <p>4 x C-H = 4 x 412 = 1648 1 x C=C = 612 3 x O=O = 3 x 496 = 1488 total bond breaking = 3748</p>	→	<p>bond making</p> <p>4 x C=O = 4 x 743 = 2972 4 x O-H = 4 x 463 = 1852 total bond making = 4824</p>
<p>difference between the two values is 1076 reaction is exothermic as bond making value is higher than bond breaking Answer: - 1076kJmol⁻¹</p>		

2)

<p>bond breaking</p> <p>1 x N≡N = 944 3 x H-H = 3 x 436 = 1308 total bond breaking = 2252</p>	<p>bond making</p> <p>6 x N-H = 6 x ?</p>	<p>overall energy change</p> <p>- 92</p>
<p>2252 + 6? = -92 6? = -92 - 2252 6? = - 2344 ? = 2344/6 ? = 390.66 Ans 391kJmol⁻¹</p>		

3)

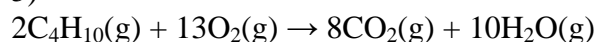
<p>bond breaking</p> <p>6 O=C=O + 6 H-O-H</p>	<p>bond making</p> <p>+ 6 O=O</p>
<p>12 x 743 + 12 x 463 = 8916 + 5556</p>	<p>7 (C-H) + 7 (C-O) + 5 (O-H) + 5 (C-C) + 6 O=O</p>

= 14472	$7 \times 412 + 7 \times 360 + 5 \times 463 + 5 \times 348 + 6 \times 496$ $2884 + 2520 + 2315 + 1740 + 2976$ $= 12435$
reaction must be endothermic as bond breaking value is higher than bond making value, although common sense tells us this anyway as for Photosynthesis to occur light energy is required The answer is + 2037 kJ mol ⁻¹	

4)

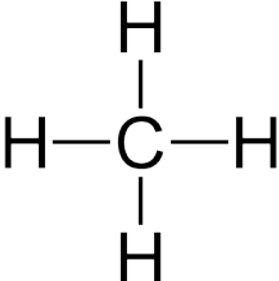
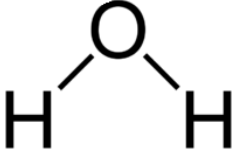

bond breaking $1 \times \text{N-N} = 163$ $4 \times \text{N-H} = 4 \times 388 = 1552$ $1 \times \text{O=O} = 496$ total bond breaking = 2211	bond making $\text{N} \equiv \text{N} = 944$ $4 \times \text{H-O} = 4 \times 463 = 1852$ total bond making = 2796
difference between the two values is 585 reaction is exothermic as bond making value is higher than bond breaking Answer: - 585kJmol⁻¹	

5)



bond breaking $6 \times \text{C-C} = 6 \times 348 = 2088$ $20 \times \text{C-H} = 20 \times 412 = 8240$ $13 \times \text{O=O} = 13 \times 496 = 6448$ total bond breaking = 16776	bond making $16 \times \text{C=O} = 16 \times 743 = 11888$ $20 \times \text{H-O} = 20 \times 463 = 9260$ total bond making = 21148
difference between the two values is 4372 reaction is exothermic as bond making value is higher than bond breaking Answer: - 4373kJmol⁻¹	

6)

bond breaking			bond making		overall energy change
				3 H-H	

4 C-H 4 x 412	2 O-H 2 x 463		1 C≡O	3 H-H 3 x 436	+206 kJmol ⁻¹
1648	926		?	1308	+206

$$2574 - (1308 + ?) = +206$$

$$1266 + ? = +206$$

$$? = +206 - 1266$$

$$? = 1060 \text{ kJmol}^{-1}$$

7)

1 molecule of S ₈	4 molecules of S ₂	1 molecule of O ₈	4 molecules of O ₂
8 x S-S = 8 x 264 = 2112 kJmol ⁻¹	4 x S=S = 4 x 352 = 1408 kJmol ⁻¹	8 x O-O = 8 x 146 = 1168 kJmol ⁻¹	4 x O=O = 4 x 496 = 1984 kJmol ⁻¹
<p>as can be seen from the values above, considerably more energy is required to break the eight single bonds between 8 sulfur atoms in S₈, 2112 kJ of energy is required, compared to 1408 kJ of energy required to break four S=S bonds in four molecules of S₂</p> <p>So, sulfur tends to form 1 S₈ molecule</p>		<p>as can be seen from the values above, considerably more energy is required to break the four double bonds between 4 oxygen atoms in O₂, 1984 kJ of energy is required, compared to 1168 kJ of energy required to break eight O-O bonds in 1 molecule of O₈</p> <p>So, oxygen tends to form O₂ molecules</p>	